Attorney Docket No. 20496-248

IN THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US)

Patent Application of	:	Rolf BODE; Ilse HECKELMANN
International Application No.	:	PCT/EP98/04845
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Priority Date	:	September 12, 1997
Title of the Invention	:	PROCESS FOR THE PRODUCTION OF STOVE-FINISHED STRUCTURAL COMPONENTS FROM AGEING-SENSITIVE STEEL

TRANSMITTAL LETTER TO UNITED STATES DESIGNATED/ ELECTED OFFICE (DO/EO/US)

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Date of Deposit March 10, 2000

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Assistant Commissioner for Patents
Washington, D.C. 20231

Sir:

Applicant(s) respectfully submit(s) the following items for entry of the above-identified international application into the national phase:

(1) [X] This express request to immediately begin national examination procedures under 35 U.S.C. §371 of the application.

(2) [X] The Commissioner is hereby authorized to deduct the large entity fee of **$880.00** from deposit account number **16-2500** of the undersigned:

[X] basic National fee pursuant to 37 CFR 1.492(a)(5) (filing with EPO or JPO search report)

[ ] basic National fee pursuant to 37 CFR 1.492(a)(3) (neither IPEA nor ISA fee paid to USPTO)

[ ] surcharge for late filing of National fee or Oath/Declaration

[ ] __ independent claims in excess of 3
__ claims in excess of 20
__ multiple dependent claims

[ ] 1/2 reduction for filing by small entity

[ ] surcharge - late filing of English translation

[X] fee for recording the enclosed Assignment

(3) [X] A copy of the international application as filed and published (in German).

(4) [X] A translation into English of the originally filed international application.

(5) [X] Declaration and Power of Attorney.

(6) [X] A copy of the International Preliminary Examination Report (in German).

(7) [X] Amendments according to Article 34 dated September 29, 1999 (in German).

(8) [X] Translation into English of Article 34 amendments dated September 29, 1999.

(9) [ ] A translation into English of the amended claims.

(10) [X] Information Disclosure Statement.

(11) [X] PTO-1449 form and listed references.

(12) [X] Assignment Document and Cover Sheet.

(13) [ ] Small Entity Declaration.

(14) [X] A copy of the International Search Report (in German).

(15) [X] Translation into English of International Search Report.

(16) The above checked items are being transmitted:

(a) [ ] before the 18th month publication.
(b) [ ] after publication and the Article 20 communication but before 20 months from the priority date.
(c) [ ] after 20 months but before 22 months.
(d) [ ] after 22 months.
(e) [X] by 30 months and a proper demand for International Preliminary Examination was made by the 19th month from the earliest claimed priority date.

(17) [ ] Other:

If any fee submitted at any time in this case be found insufficient, please debit the balance to the Patent Office Account No. 16-2500 of the undersigned; if any other deficiency in the papers submitted be found that may result in a delayed filing date, please notify the undersigned attorney by telephone at (212) 969-3000.

Respectfully submitted,
PROSKAUER ROSE LLP
Attorneys for the Applicant(s)

By: _____
Charles Guttman
Reg. No. 29,161

Date: March 10, 2000

PROSKAUER ROSE LLP
1585 Broadway
New York, N.Y. 10036

Tel: (212) 969-3000

PROCESS FOR THE PRODUCTION OF STOVE-FINISHED STRUCTURAL COMPONENTS FROM AGEING-SENSITIVE STEEL

The invention relates to a process for the production of a buckling-resistant stove-finished structural member from cold rolled and dressed strip (cold strip) from non-ageing steel with high bake-hardening potential, more particularly of more than 70 N/mm^2.

To achieve a high bake-hardening potential as a rule use is made of steels which contain dissolved nitrogen as well as dissolved carbon. Examples of these are unkilled steels. The storage of strips of such steels at room temperature leads even after the short time of one or two days to ageing processes which make impossible any satisfactory further processing, more particularly cold working. There is also an adverse effect on the surface texture of the cold strips.

Ageing can be caused by the diffusion of dissolved carbon and/or nitrogen. In the case of pure carbon ageing the effect of temperature on ageing time can be estimated as follows: The times t_1 and t_2 required for identical ageing effects stand in converse ratio to the associated temperature-dependent coefficients of diffusion of carbon in α iron.

In the temperature range up to 100°C we therefore have

$$t_1\,(T_1)/t_2(T_2) = D(T_2)/D(T_1) =$$

$$= \frac{\exp\,(-21.1\ /\ (1{,}987 \cdot 10^{-3} \cdot T_2)}{\exp\,(-21.1\ /\ (1{,}987 \cdot 10^{-3} \cdot T_1)} \qquad [1]$$

with $T_{1,2}$ in K.

Table 1 shows the factors calculated according to equation [1] for the delay in time of an ageing effect due to lowered temperatures. For example, in comparison with ageing at room temperature, ageing at -10°C lengthens ageing time by 62 times.

Table 1

Ageing temperature (°C)	10	5	0	-5	-10
Factor [1)]	3.6	7	14	29	62

[1)] Factor for the delay in time of an ageing effect at different temperatures in comparison with room temperature for ageing by dissolved carbon according to equation [1]

The quantity of description of the effect of dissolved nitrogen on steel ageing can be carried out similarly to the description of carbon ageing according to equation [1], using the coefficient of diffusion for nitrogen. The connection between ageing time and ageing temperature is therefore obtained as follows:

$$t_1\,(T_1)/t_2(T_2) = D(T_2)/D(T_1) =$$

$$= \frac{\exp\,(-18.33\ /\ (1{,}987 \cdot 10^{-3} \cdot T_2)}{\exp\,(-18.33\ /\ (1{,}987 \cdot 10^{-3} \cdot T_1)} \qquad [2]$$

with $T_{1,2}$ in K.

Table 2 shows the factors calculated according to [2] for the delay in ageing effect caused by dissolved nitrogen.

Table 2

Ageing temperature (°C)	10	5	0	-5	-10
Factor [2)]	3.1	5.5	14	19	36.5

[2)] Factor for the delay in time of an ageing effect at different temperatures in comparison with room temperature for ageing by dissolved nitrogen according to equation [2]

It is an object of the invention to provide a process for the ageing-free further processing of cold strips of an ageing-sensitive steel with high bake-hardening potential to produce a stove-finished structural component.

To resolve this problem the invention provides a process as set forth in claim 1 or a process as set forth in claim 3.

In the process according to claim 1 the ageing of dressed cold strip is suppressed by its storage at low temperature. In the alternative process set forth in claim 3, due to the bake-hardening effect triggered thereby the stove-finishing performed shortly after further shaping processing prevents the ageing of the cold strip dressed shortly prior to further processing.

To make use of the positive effect of a lowering of the surrounding temperature during the storage of cold strips, the storage temperature T in K (degrees Kelvin) can be estimated as follows, in dependence on the planned storage time in hours:

$$T = 9225 / (31.48 - \ln (48/t) \quad [3]$$

Equation [3] follows from equation [2] and relates to a steel which can no longer be satisfactorily processed, due to nitrogen ageing after exceeding a storage time of more than 2 days at 20°C. In the case of ageing by both elements, it is enough to allow for nitrogen only, due to the lower diffusion speed of carbon in comparison with nitrogen.

As an example, the change in material properties due to ageing at different temperatures was measured on a cold strip of a steel containing 0.003% C, 0.27% Mn, 0.003% Si, 0.007% P, 0.006% S, 0.046% A1, 0.001% N and Cu+Ni+Cr < 0.1% (values in % by weight). After hot and cold rolling the steel was galvanised in a continuous fire-coating installation with a maximum annealing temperature of 820°C and then subjected to 1.5% dressing. The difference between the upper and lower yield points ($R_{eh}-R_{el}$) was evaluated from the tensile test as a measure of the risk of stretcher strains.

Fig. 1 shows the development in time of $R_{eh}-R_{el}$ at room temperature, 60°C and 100°C. Value $R_{eh}-R_{el}$ = 2 N/mm² can be regarded as the limit value for fault-free processing. With higher values than 2 N/mm² the occurrence of stretcher strains must be expected, since there is a marked drop in load in the stress/strain curve.

In Fig. 2 the associated time for reaching the value $R_{eh}-R_{el}$ = 2 N/mm² is plotted Arrhenius-fashion for each temperature. As in the case of all diffusion-controlled processes, the result in good approximation is a straight line.

The effect of a further lowering in temperature can be determined by lengthening the straight line with the values from Table 3.

Table 3

Ageing temperature [°C]	30	20	5	0	-5	-10
Ageing time [3] [h]	56 (2,3 days)	174 (7,3 days)	1118 (6,7 wks)	2170 (13 wks)	4320 (26 wks)	8830 (53 wks)

[3] Time for reaching Reh-Rel = 2 N/mm² with different ageing temperatures from the example of steel A (Arrhenius dependence, Fig. 2)

While the critical value of ageing resistance is reached at 30°C and 20°C after 2 and 7 days respectively, processing free from stretch strains is ensured up to 13 weeks at 0°C and even up to one year at -10°C.

Table 4 lists the mechanical values of the steel, its 0.2% proof stress ($Rp_{0.2}$), tensile strength (Rm), elongation (A80), elongation without necking (Ag), the r value and its bake-hardening potential BH_0, and also the contents of dissolved C and N in the starting condition.

Table 4

$Rp_{0.2}$ N/mm²	Rm N/mm²	A80 %	Ag %	r value	BH_0 N/mm²	$C_{diss.}$ ppm	$N_{diss.}$ ppm
215	310	44	23.5	1.75	73	30	< 1

By the use of one of the two processes according to the invention a steel which has high contents of dissolved carbon and/or nitrogen and is not ageing-resistant at room temperature can be further processed without the risk of surface faults even after a prolonged storage period.

The advantage of the process according to the invention lies in the utilisation of a high bake-hardening potential to produce steels from which structural components can be made which have higher buckling resistance in comparison with conventional bake-hardening steels resistant to ageing at room temperature.

CLAIMS

1. A process for the production of a buckling-resistant stove-finished structural member from cold rolled and dressed strip (cold strip) from non-ageing steel with high bake-hardening potential, more particularly of more than 70 N/mm², **characterised in that** the cold strip is converted by dressing into a yield point stretch-free state (R_{eh}-R_{el} < 2 N/mm²), then stored at a temperature below room temperature and further processed into the form of the structural member, whereafter the strip is finally stove finished.

2. A process according to claim 1, **characterised in that** the storage temperature T in K of the cold strip is selected in dependence on the planned storage time t in h in accordance with the equation

$$T = 9225 / (31.48 - \ln (48/t)) \qquad [3].$$

3. A process for the production of a buckling-resistant stove-finished structural member from cold rolled and dressed strip (cold strip) from non-ageing steel with high bake-hardening potential, more particularly of more than 70 N/mm², **characterised in that** the cold strip is stored undressed at room temperature and after the storage time has elapsed is converted by dressing to a yield point strech-free state (R_{eh}-R_{el} < 2 N/mm²) and then further processed to the form of the structural member, whereafter the structural member is finally stove-finished.

ABSTRACT

The invention relates to processes for the production of a buckling-resistant stove-finished structural member from cold rolled and dressed strip (cold strip) non-ageing steel with high bake-hardening potential, more particularly of more than 70 N/mm². The characterising feature of the invention is that the cold strip is converted by dressing into a yield point stretch-free state (R_{eh}-R_{el} < 2 N/mm²), then stored at a temperature below room temperature and further processed into the form of a structural member, whereafter the strip is finally stove finished.

For publication: No drawings

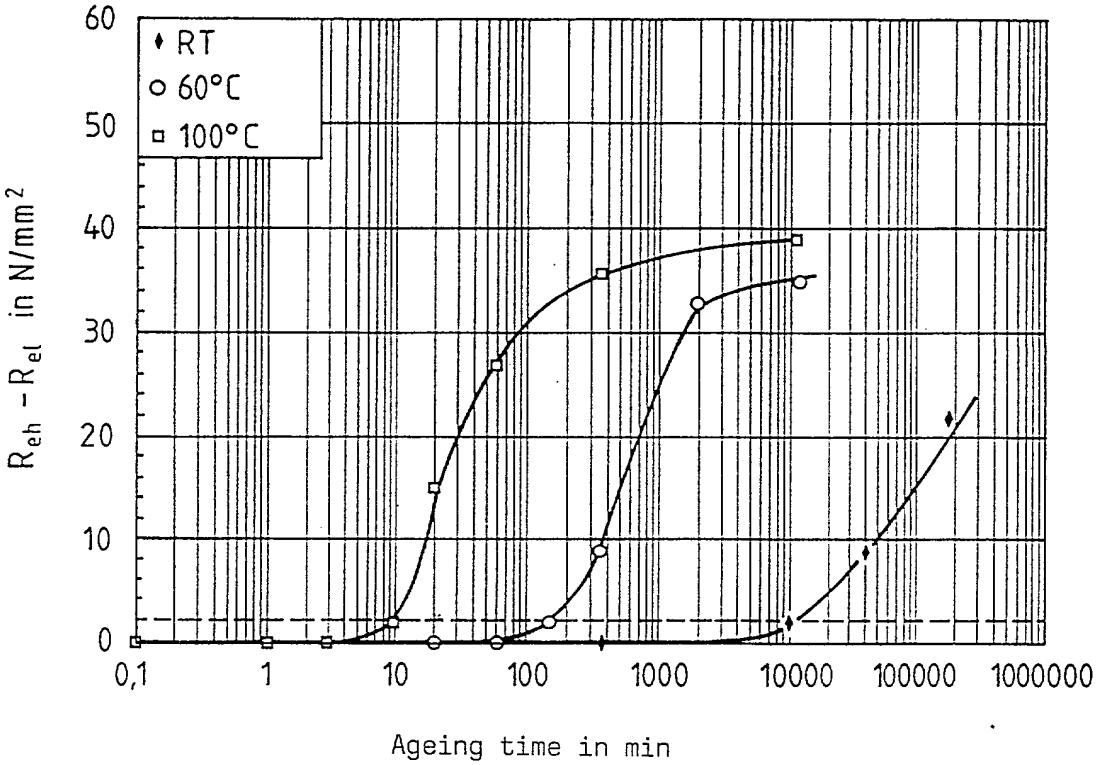
RT
60°C
100°C
$R_{eh} - R_{el}$ in N/mm²
0
10
20
30
40
50
60
0,1
1
10
100
1000
10000
100000
1000000
Ageing time in min

Fig.1

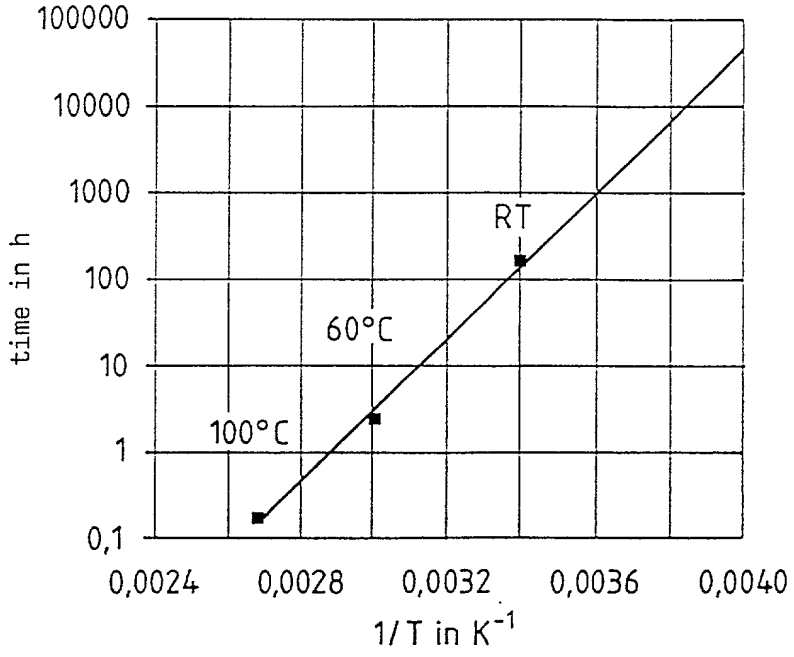
time in h
100000
10000
1000
100
10
1
0,1
RT
60°C
100°C
0,0024
0,0028
0,0032
0,0036
0,0040
1/T in K⁻¹

Fig.2

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DECLARATION FOR PATENT APPLICATION

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name.
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

METHODS FOR PRODUCING CONSTITUENT MEMBERS MADE OF AGEING-SENSITIVE STEEL AND COATED WITH BAKING ENAMEL

the specification of which is attached hereto unless the following box is checked:

X was filed on **August 4, 1998** as United States Application Number or PCT International Application Number **PCT/EP98/04845** and was amended on **September 29, 1999** (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a) or § 365(b) of any foreign application(s) for patent or inventor's certificate, or § 365(a) of any PCT International application which designated at least one country other than the United States, listed below and have also identified, by checking the box, any foreign application for patent or inventor's certificate, or PCT International Application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)			Priority Not Claimed
197 40 148.1	**Germany**	**12/ 09 / 97**	
(Number)	(Country)	(Day/Month/Year Filed)	

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below.

(Application Number)	(Filing Date)
(Application Number)	(Filing Date)

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s), or § 365(c) of any PCT International application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application and the national or PCT International filing date of this application.

(Application Number)	(Filing Date)	(Status--patented, pending, abandoned)
(Application Number)	(Filing Date)	(Status--patented, pending, abandoned)

I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith: **Charles Guttman, Reg. No. 29,161; Kenneth Rubenstein, Reg. No. 30,586; Evan L. Kahn, Reg. No. 35,912; Anthony C. Coles, Reg. No. 34,139; Gregg I. Goldman, Reg. No. 38,896; Betty A. Ryberg, Reg. No. 42,119.**

Address all telephone calls to **Charles Guttman** at telephone number: **(212) 969-3000**
Address all correspondence to **Proskauer Rose LLP**
1585 Broadway
New York, New York 10036

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

Full name of the first or sole inventor (given name, family name): **Rolf BODE**	
Inventor's signature: > Rolf Bode	**Date: >** 29.2.2000
Residence: Wesel, Germany DEX	**Citizenship: German**
Post Office Address: AM Friedenshof 46, 46485 Wesel, Germany	

Full name of the second inventor (given name, family name): **Ilse HECKELMANN**	
Inventor's signature: > Ilse Heckelmann	**Date: >** 29.2.2000
Residence: Xanten, Germany DEX	**Citizenship: German**
Post Office Address: Ulmenweg 43, 46509 Xanten, Germany	